Among the special essays may be mentioned the following: "Napier and the Invention of Logarithms," by Professor Gibson, of Glasgow, perhaps the best essay which has appeared upon the great Scotch mathematician; "Notes on the Special Development of Calculating Ability," by Dr. W. G. Smith, an excellent summary of the history and psychology of the subject; "Calculating Machines," by F. J. W. Whipple, a description of the standard engines of calculation written from the standpoint of the practical computer and elaborating the descriptive catalogue prepared for the Fifth International Congress of Mathematicians in 1912; "The Calculating Machine of the East: the Abacus," by Dr. C. G. Knott, the efficient secretary of the Royal Society of Edinburgh, and one of the prime movers in the Napier Celebration—a classical essay upon the subject and one which has been out of print for nearly thirty years; "The Slide Rule," by Dr. G. D. C. Stokes, a historical review of the various types of these instruments; "Integraphs," by Charles Tweedie; "Integrometers," "Planimeters" and "Harmonic Analysis," by Dr. G. A. Carse and Mr. J. Urquhart; "Integrating Machines in Naval Architecture," by A. M. Robb; "A Differentiating Machine," by Dr. J. Erskine Murray; "Tide-predicting Machines," by Edward Roberts; "A Mechanical Aid in Periodgram Work," "A Mathematical Description of Conics" and "The Instrumental Solution of Numerical Equations," by D. Gibb; "Ruled Papers," by E. M. Horsburgh; "Collinear-point Nomograms," by Professor D'Ocagne; "Mathematical Models," by Professor Crum Brown; and "Closed Linkages," by Colonel R. L. Hippisley. Besides these essays, numerous shorter notes appear, all of them written by experts in their fields.

A catalogue of the mathematical portraits in the collection of W. W. Rouse Ball, the well-known writer on the history of mathematics, will prove of value to all collectors.

It is impossible in the space at our disposal to speak in detail of any of the essays, several of them profusely illustrated and all of an authoritative nature. Suffice it to say that the book should be in every mathematical library and workshop as being the most valuable treatise of its kind that we have in English, and, indeed, about the only one in any language except such as is found in the articles in the German encyclopædia.

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Die Elemente der Entwicklungslehre des Menschen und der Wirbeltiere. Anleitung und Repetitorium für Studierende und Aerzte. VON OSCAR HERTWIG. 5te Auflage. Jena, Gustav Fischer, 1915. Pp. x + 464. 416 figs.

This work, already well known through former editions, must be regarded as among the *opera minora* of its distinguished author. It is professedly a utilitarian text-book, and discussions not adapted to "comprehensive brief presentation, suitable for a text-book," have been omitted. For further information, Professor Hertwig appropriately refers the student to his "Lehrbuch," ninth edition, his "Allgemeine Biologie," fourth edition, and the imposing "Handbuch der Entwickelungsgeschichte der Wirbeltiere," which he edited and to which he contributed important chapters.

The fourth edition of the "Elements" was published in 1910 and the present volume, although reset throughout, contains only minor changes—chiefly such as are designed to make the book more useful to students of medicine. Except that Hochstetter's series of diagrams of the development of the vena cava inferior has been replaced by Kollmann's drawings of the same subject, all the figures in the last edition have been republished. To these are added sixteen others, eight of which show young human embryos and their adnexa, three illustrate cleft palate, two pertain to the vascular system, and the remaining three represent the *tunica vasculosa lentis,* the human branchial region and one of Keibel's models of the urogenital tract, respectively. None of the new figures is original, for Professor Hertwig is not of those who, on seeing a good drawing, make another much like it to be called their own. He prefers to present to the students a

wide selection of familiar figures, which have served, quite as much as the text which accompanied them, to advance the science of embryology.

Chapter 1 begins with the following interesting statement:

> In the seventeenth and eighteenth centuries, the most confused ideas of the nature of the process of animal development still prevailed. Influenced involuntarily by the religious dogmas of their time, the greatest anatomists and physiologists, with few exceptions, were of the opinion that the germ was merely a much reduced miniature of the later fully developed condition.

Was not the idea of preformation a direct result of observation and reflection upon natural phenomena, quite apart from "religious dogmas"? This indeed appears to be true, and the comment of a distinguished theologian upon Professor Hertwig's statement is as follows:

> Let the men of science assume the parentage of their own *homunculi!* I certainly know of no dogma that the germ was a miniature of the man that was to be, nor even a doctrine which could be understood or misunderstood in that sense.

Thus it appears that this introduction needs explanation or revision. The entire work might profitably be expanded at many points, notably so as to include some account of the development of the lymphatic system. But the title of the book disarms such criticism; the *elements* are admirably presented in a text which is simple, direct and substantial throughout.

Frederic T. Lewis

SPECIAL ARTICLES

ELECTRICAL DENSITY AND ABSORPTION OF β-RAYS

There have been a number of attempts to relate the absorption coefficients of various bodies for the β-radiation to some physical properties of the absorbing substance. In 1895, Lenard determined the absorption coefficients for cathode rays of a number of bodies, and concluded that the absorption varied approximately as the density, though his values of μ/D differed by more than one hundred per cent. Similar results were obtained for the absorption of β-rays from radium and uranium by Strutt and by Rutherford.

The first to determine the absorption coefficient of a considerable number of elements for the β-rays was Crowther, in 1906.[1] Crowther found the ratio of the absorption coefficient to the density of the elements to increase with the atomic weight of the absorbing element, but apparently not according to any regular law. Crowther, however, plotted the ratio of the absorption coefficient to the density of 31 elements against their respective atomic weights, and obtained a number of points which he divided into groups having no apparent physical or chemical relationships, and showed that the elements in each of these groups could be joined by curves having some resemblance to one another.

It is the purpose of this paper to show that the absorption coefficient of the elements for β-rays is dependent rather upon the electrical density of the absorbing agent than upon its mass density.

It has been shown in a number of papers by the present writer how the electrical charges of the dissociated ions in an electrolytic solution may be calculated from their masses and their migration velocities in an electric field. Knowing these charges and the volume occupied by a gram-atom of an element in its solid state, we may calculate the electric density of the element by dividing its atomic charge by its atomic volume. It is the electric density calculated in this way which seems to be an important determining factor in the absorption of the β-radiation.

Unfortunately, only a small number of atoms have had their charges calculated in this way, but eleven of these are included in the list of thirty-one elements whose absorption coefficients for the β-rays of uranium were determined by Crowther.

In the table below column ii contains the values of λ/ρ for these eleven elements taken

[1] *Phil. Mag.*, 12, p. 379 (1906).